

NASA GTE TRACE-P Augmentation

Final Report

Submitted to:  
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## Introduction:

There were three major tasks and objectives that the Tropospheric Trace Gas and Airborne Measurement Group's (TTGAMG) worked on for different aspects of this grant:

1) Migrate the data acquisition system from HP-UX to Linux, thus reducing future costs as the result of software and operating system (OS) upgrades and improving upon usability as membership in the group changes.

2) Rework the Optical Parametric Oscillator (OPO) cavities. These are the OPOs that are integral to the Georgia Institute of Technology Airborne Laser Induced Fluorescent Experiment (GITALIFE) that the TTGAMG flew on TRACE-P. The objective was to improve upon optimizing the pump laser energy and narrowing the linewidth of the UV wavelength generated by the OPOs.

3) Improve and expand the interactive website on <http://tmbk2.eas.gatech.edu> by adding 3-D graphing, improve the response time for Joe Surfer Dude, improve performance, usability, and expand the database.

If I were to assign a letter grade to each of the above tasks, I would give the TTGAMG two Bs and an A to the tasks listed above.

## Summary of Results:

The first task listed above was completed in early summer. I told Joe Mastromarino that if we were integrating on the DC-8 today, we would be flying the Linux version of our data acquisition code. The end product was not what was envisioned at the onset of the project. First, the Hewlett Packard VXI slot zero controllers were replaced with National Instrument (NI) controllers, along with the Linux OS and NI VESA and VXI libraries. The hardware and OS changes went without a hitch. Unfortunately, I cannot say the same for the NI VXI and VISA libraries. We had numerous issues with the VESA library that were integral to getting the scanning A/D to work. The analog out, digital IO, IRIG time code, and digital delay generators

went nearly as expected. After numerous phone calls between the TTGAMG, the local NI representative, and/or the Linux based support in Texas, a conference call was held with the local NI representative in the TTGAMG's laboratory and NI folks in Texas. A library upgrade was forth coming and we finally made progress on the TTGAMG code migration to Linux. Dr. Robert E. Stickle, along with a graduate student Vernard Martin and an undergraduate Thomas Shanks completed this portion of the project. Vernard and Thomas's main tasks were associated with the functionality of the DIO, analog out, RS-232, and IEEE-488. Bob drew the short straw and was assigned the far more difficult tasks of the scanning A/D, IRIG-B, Oscilloscope, the daemon and the issues associated with the use of shared memory. The four of us are still discussing the option to post our code without the NI VESA and VXI libraries on an open source website such as <http://sourceforge.net>. The fundamental problem we are unable to get away from is the need for NI's proprietary VXI and VESA libraries and therefore the inability to cut ourselves free from future costs associated with software upgrades. As Linux continues to grow and mature, the TTGAMG will be driven to upgrade our OS at no expense, but we still will need NI to upgrade the VXI and VESA libraries, something NI is slow at and not all that willing to partake in. The goal to become completely software license free by migrating away from HP-UX to Linux will not be completely attained. Thus we are still stuck with some closed source software libraries that we cannot fix or patch.

The second task all fell on Joe Mastromarinos shoulders, our resident laser expert. He made major changes to UV wavelength OPO cavities. They are no longer pumped with the third harmonic of the GCR lasers. We are now using 355 nm, the second harmonic, and doubling and mixing the new OPOs outputs. This is almost exactly what John Bradshaw did when the TTGAMG flew DCRs YAG lasers, rather than GCRs, and dye lasers prior to NASA GTE PEM Tropics A. We are experiencing far less crystal damage with this new design, which should keep further costs down. We

can also now produce the 226 nm UV wavelength necessary for NO detection, and the 236 nm need for vibrationally excited NO at the same time. An option we were not able to do during the TRACE-P field deployment. Joe has narrowed the linewidth of the OPO cavities through the use of etalons but at the expense of laser energy. Dave Tan is hoping that the higher on wavelength peak power, a result of line narrowing, and the lower average power will not hurt the sensitivity of GITALIFE.

Last, but certainly not least on the task list are the improvements in the interactive website (<http://tmbk2.eas.gatech.edu>). A new user front end was installed in order to make it easier for the average Joe Surfer Dude to use the website. Flight maps were added so Joe Surfer Dude knew where the field program took place. Several web pages were added to help explain what is on the website, where it came from, and how one could use the website. Dr. Robert E. Stickel cut the code for the original x-y graphing option which served as the foundation for this expansion, making Bob the perfect candidate to undertake the hurdles associated with adding the option of generating three dimensional graphs. Vernard was also closely involved with the 3-D code. While Bob and Vernard were cutting 3-D code, I was downloading and running our in house peril based merging code on other NASA airborne field programs. These new field program data sets to our database were downloaded from NASA Ames. Unfortunately, the TTGAMG has run out of time and funds. There are several more data sets that we would have liked to add to the interactive website. We did not even begin to investigate balloon born field measurement programs. There are also numerous NCAR and NOAA airborne field programs that could be added to the database once new funds and time have been identified. I am currently negotiating with NASA Langley (the home of the GTE field program) to move the interactive graphing code on <http://tmbk2.eas.gatech.edu> to Langley and have it integrated into the GTE website.

### Conclusion:

Clearly, there are more tasks to do and more that can be done on all three of these tasks. This is especially true regarding the OPO cavities and the interactive website. The website is very much in need of a Thesaurus, Dictionary, and an Encyclopedia. The average Joe Surfer Dude has no working knowledge of airborne field programs, their terminology, or their instrumentation. Some forms of documentation will have to be added to the website at some point if we expect the average citizen, or better yet, the average K-12 student to be able to effectively use this website to better understand the chemical composition of the earth's atmosphere. The hints, tips, and tricks text on the website barely begins to scratch the surface on these issues. This puts the interactive website as a tool mostly for those that have participated in at least one of these field programs.

### Students associated with the project:

Ms. Srujana Gali

Mr. Thomas Shanks

Mr. Vernard Martin

### Other senior research scientists associated with the project:

Dr. Robert E Stickel

Mr Joesph Mastromarino

### Travel:

The grant funded David Tan's travel to the 2002 Fall AGU meeting where he presented a poster related to the NASA GTE TRACE-P field program.